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# Stability of Concrete Macro-Roughness Linings for Overflow Protection of Earth Embankment Dams ([1]) - Discussion

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The writers presented a challenging and detailed study of embankment overflow spillway systems. There are indeed numerous applications worldwide for both dam refurbishments and new structures.

During the last two decades, a number of embankment dam spillways were designed with concrete overtopping protection shaped in a stepped fashion (Chanson 2001 pp. 220-230). During the 1990s, the construction of secondary stepped spillways accounted for nearly two-thirds of dam construction in USA (Ditchey and Campbell 2000). The preferred construction method was roller compacted concrete overlays placed on the downstream slope. Figure 1 presents two examples. Figure 1a shows the Melton dam secondary spillway completed in 1994. With a discharge capacity $Q_{des}$ = 2,800 $m^3/s$, it is the world's largest embankment stepped spillway (Chanson 2001, pp. 221-223). Figure 1b shows a newer embankment dam designed and built with a secondary stepped spillway system ($Q_{des}$ = 481 $m^3/s$). While most research on stepped spillway hydraulics focused on steep chutes for gravity dams ($\alpha \sim 50°$), recent studies brought new insights into the complicated overflow hydrodynamics (Chanson and Tombes 2001,2002, Gonzalez 2003).

A very different concept of overflow embankment spillway is the Minimum Energy Loss (MEL) weir design. The concept of MEL weir was developed by late Professor Gordon R. McKay (1913-1989) to pass large floods with minimum energy loss, hence with minimum upstream flooding. The first MEL weir design was the Sandy Creek weir at Clermont (Qld, Australia 1962) (Fig. 2a). The largest, Chinchilla weir (Qld, Australia 1973), is listed as a "large dam" by the International Commission on Large Dams (Fig. 2b). A MEL weir is typically curved in plan with converging chute sidewalls and the overflow spillway chute is relatively flat (Fig. 2). The downstream energy dissipator is concentrated near the channel centreline away from the banks. The inflow Froude

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[1]MANSO, P.A., and SCHLEISS, A.J. (2002), *Can Jl of Civil Eng.*, Vol. 29, No. 5, pp. 762-776.

number remains low and the rate of energy dissipation is small compared to a traditional weir. For example, both Clermont and Chinchilla weirs were designed to give no afflux at design flow $Q_{des}$. In 1974, the Chinchilla weir passed 1,130 $m^3/s$ with a measured afflux of less than 100 mm (Turnbull and McKay 1974). Ideally a MEL weir could be designed to achieve critical flow conditions at any position along the chute and, hence, to prevent the occurrence of a downstream hydraulic jump (Chanson 1999, pp. 418-419). This is not always achievable because the variations of the tailwater flow conditions with discharge are often important. MEL weirs are typically earthfill structures and the spillway section is protected by concrete slabs. Construction costs are minimum. A major inconvenient is the overtopping risk during construction : e.g., Clermont weir in April 1963, Chinchilla weir twice in 1972 and 1973. In addition, an efficient drainage system must be installed underneath the chute slabs.

In summary, embankment overtopping has become an attractive design option. Several design techniques may be considered ranging from concrete block linings, precast concrete steps, roller compacted concrete overlays to the Minimum Energy Loss weir design.

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(b) Choctaw 8A dam auxiliary spillway (Courtesy of Craig Savela and USDA Natural Resources Conservation Service) ($Q_{des}$ = 481 $m^3/s$, h = 0.61 m, $B_{crest}$ = 51.8 m)

**Fig. 2** - Photographs of Minimum Energy Loss weirs

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